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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/633,500	08/05/2003	Shye-Lin Wu	BHT-3167-149	5214

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BRUCE H. TROXELL
SUITE 1404
5205 LEESBURG PIKE
FALLS CHURCH, VA 22041

EXAMINER	
MALSAWMA, LALRINFAMKIM HMAR	
ART UNIT	**PAPER NUMBER**
2823	

DATE MAILED: 05/25/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

AK

Office Action Summary	Application No.	Applicant(s)	
	10/633,500	WU, SHYE-LIN	
	Examiner	Art Unit	
	Lex Malsawma	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *02 May 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *7 and 9-18* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *13,17 and 18* is/are rejected.

7)☒ Claim(s) *7,9-12 and 14-16* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *05 August 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on May 02, 2005 has been entered.

Claim Objections

2. Claims 7 and 9-18 are objected to because of the following informalities:

In claim 7, line 20, "mesas" should read "mesa".

Claims 9 and 10 should depend from "Claim 1" instead of canceled "Claim 8".

In claims 10 and 16, line 2 of each claim, before "surface", the examiner suggests changing "the" to "a" to clearly distinguish from "the first surface" of the semiconductor substrate (note claims 7 and 13, lines 2-3 of each claim).

In claim 13, line 9, the examiner suggest changing "epi-layer" to read "epi layer" for consistency with "epi layer" in lines 3 and 13.

In claim 13, line 10, the examiner suggests changing "surrounded" to "surrounding".

In claim 13, line 13, the word, "said", should be inserted before "epi layer".

In claim 13, line 15, the examiner suggests changing "acted" to "acting".

In claim 13, line 16, "mesas" should read "mesa".

Claims 11, 12, 14, 17 and 18 are objected to because they depend from claim 7 or 13.

Appropriate correction is required.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 13 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Saltich et al. (3,668,481; hereinafter "**Saltich**") in view of Chang et al. (6,404,033 B1; hereinafter "**Chang**").

Regarding claims 13 and 17:

Saltich discloses a power rectifier device, comprising:

a semiconductor substrate 10 (in Fig. 5) having a first conductive layer doped with first-type impurities (N+), an epi layer 13 formed thereon which is extended to a first surface thereof and is lightly doped (N-);

a first oxide layer 14 (Figs. 2-5) formed on said first surface;

a trench (Fig. 4) formed through said first oxide layer 203 and into a top of said epi-layer 13;

a termination mesa region surrounding the trench (Fig. 4), i.e., the trench defines mesas on it sides (as viewed in Fig. 4) and these mesas can be referred to as a termination mesa region;

a second conductive type doped region 22 (Fig. 4) formed beneath all remnant portions of said first surface;

a Schottky barrier platinum-silicide layer 24 formed on the epi layer located on bottom and side surfaces of said trench (Fig. 5 and Col. 3, lines 21-26); and

a top metal layer 26 formed on said Schottky barrier silicide layer 24 and extended to cover a portion of said termination mesa region.

Saltich **lacks** (1) a cathode metal layer on a side opposite to the first surface; (2) a pair of trenches (instead of only one) defining a first mesa region; (3) specifically reciting that the top metal layer 26 acts as an anode; and (4) the top metal layer extended to cover all surfaces of the first mesa region. In references to items "(1)" and "(3)", Saltich does not specifically disclose all elements necessary for a complete device; however, one of ordinary skill in the art would have readily recognized that a cathode metal layer would be formed on the "bottom side" of the substrate 10 and that the top metal layer 26 would obviously function as an anode because such a structure/configuration was conventional in the art (as will be shown by Chang).

Chang **teaches** a way for increasing the effective surface area of a Schottky diode (i.e., a diode similar to that disclosed by Saltich) in order to increase the current capacity of the device (note Col. 1, lines 62-66). Chang teaches that trenches are formed between a termination mesa region (note Fig. 7), wherein the trenches are spaced part from each other and define a first mesa region (i.e., the regions underneath label "28" in Fig. 7) and a termination mesa region located at the sides of the first mesa region (as shown in Fig. 7). Chang further discloses the following: a bottom electrode 34 (Fig. 8) that would obviously function as a cathode; a Schottky metal layer 32; and a top metal layer 36 extending to cover all surfaces of the first mesa region and the termination mesa region (Fig. 8).

Given Chang's disclosure, it would have been obvious to one of ordinary skill in the art to modify Saltich by incorporating at least another trench, thereby defining a first mesa region, because Chang teaches that incorporating a plurality of trenches into a Schottky diode increases

the effective surface area of the diode such that current carrying capacity increases. Furthermore, when Saltich is modified by incorporating a plurality of trenches, as taught by Chang, at least a pair of trenches will be provided and each of the limitations in items "(1)—(4)" will be included in the modified device.

3. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Saltich** (in view of **Chang**) as applied to claim 13 above, and further in view of Blanchard et al. (6,621,107 B2; hereinafter "**Blanchard**").

Regarding claim 18:

Saltich (in view of Chang) **lacks** specifically using TiNi/Ag or TiW/Al for the top metal layer. Blanchard is **cited show** that it was well known in the art that a top metal layer for a Schottky diode can be formed of TiW/Al (note Col. 8, lines 25-30). It would have been obvious to one of ordinary skill in the art to modify Saltich by specifically using a material such as TiW/Al for the top metal layer because Blanchard shows that such a material was well known and used for a top metal layer of a Schottky diode. Furthermore, note that it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416.

Allowable Subject Matter

4. Claims 7 and 9-12 are allowable over the references of record; however, note that objections have been specifically made to claims 7, 9 and 10.

5. Claims 14-16 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

6. The following is a statement of reasons for the indication of allowable subject matter:

Claims 7, 9-12 and 14-16 are allowable primarily because claims 7 and 14 require at least the following limitations (in combination with all other limitations within claims 7 and 13): a Schottky-barrier silicide located on bottom and side surfaces of the trenches (or sidewalls of the epi layer); and a nitride layer position between the first oxide layer and the top metal layer. In other words, an oxide-nitride stack will be located on each mesa region and the top metal layer covers all surfaces of the first mesa region including the oxide and nitride layers formed on the first mesa region.

Remarks

7. Applicant's remarks/arguments have been fully considered and are generally persuasive, accordingly, Blanchard has been removed as a primary reference; however, Blanchard is currently cited as a secondary reference in the rejection of claim 18.

Conclusion

8. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

The references listed on the attached Form PTO-892 (not specifically cited above) are cited to show Schottky diode structures incorporating trenches, mesas, etc..

Note that Hsu et al. (IEEE Electron Device Letters, 2001) and Chang (US 6,242,288) are listed on the attached Form PTO-892 because these two references were specifically cited in the current specification.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lex Malsawma whose telephone number is 571-272-1903. The examiner can normally be reached on Mon. - Thur. (4-12 hours between 5:30AM and 10 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Lex Malsawma

May 21, 2005